

PURDUE UNIVERSITY
Agricultural Experiment Station

CIRCULAR No. 87
LAFAYETTE, INDIANA, NOVEMBER 1918

WINTER INJURY OF FRUIT TREES

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The severe winter of 1917-18 has caused irreparable damage to thousands of peach and apple orchards in Indiana. The heaviest toll was taken of the peaches, amounting all the way from very slight or no injury to the complete destruction of entire orchard tracts. It seems



Fig. 1. A typical frost canker—with rot fungus and borers present

safe to say that for the State as a whole the damage has cut the bearing acreage of peaches at least 60 per cent. The mortality among young peach trees which had not yet borne fruit was small, however, so that in a short time normal production should be restored.

A part of the acreage where the injury was severe will probably not be planted again to peaches. This is as it should be, for many of these locations were not well adapted to such a tender fruit. While the trees in many such locations were heretofore able to survive the winters, the buds or blossoms were more commonly killed than in more favorable situations. Farm crops, occasionally apples and other relatively hardy fruits, will supplant the peach orchards in the majority of cases where

the severest injury occurred. It appears then, to be a very opportune time to take the best of care of all healthy peach orchards and even to extend the planting in choice locations.

In the case of the apple, the young trees from three to 14 years old suffered the greatest injury. While the loss has been considerable



Fig. 2. This ten-year-old Stayman Winesap has sparse foliage as the result of winter injury (photographed July, 1918)

in some sections of the State it is probable that not over three per cent. of the young apple trees of Indiana will be lost from this cause; the loss in old orchards is negligible. Reports indicate that the loss in some of the eastern states was much more extensive than in the middle-west, many bearing apple orchards as well as young ones having been killed.

Elevation and varieties were among the most important factors in influencing winter injury. A high location proved to be a decided protection for both peaches and apples. Baldwin, Stayman Winesap, Ben Davis, Northern Spy, York Imperial and Jonathan were the most tender varieties, about in the order named. Other varieties such as Grimes Golden, Winesap, and Rome Beauty showed some injury in certain sec-

tions, but this was not of sufficiently frequent occurrence to warrant classing them as at all tender. Northwestern Greening and Delicious in Indiana appear to be entirely hardy.

Since the great bulk of the commercial peach orchards of the State are Elberta, little opportunity was afforded for studying the hardiness of peach varieties.

Other fruits are of relatively minor importance in Indiana and there are only isolated cases from which to draw information. Pears have been injured somewhat more than apples. Sweet cherries were next in tenderness to the peach. Sour cherries suffered no permanent injury although in one poor location sapwood killing in spots was evident. The plums were not quite so hardy as the apples, except the American varieties which came through practically uninjured.

NATURE OF THE INJURY

The most severe injury in both the peach and apple originated in the trunk and main branches. This was undoubtedly due to the degree



Fig. 3. Crotch and trunk injury—showing distinct line of demarkation between dead and live tissue

of maturity as these portions of the tree would be the last to ripen. The extent of the injury was far greater in the peach than in the apple, the sapwood being invariably killed. In the apple, the frost cankers were particularly noticeable in the crotches of the main limbs and on the trunk on the southwest side of the tree. A line of demarkation soon appeared between the dead and living tissues and the trouble assumed much the same appearance as fire blight cankers, with brown sunken areas of dead bark. Indeed, there has been much confusion between the two. The Horticultural Department has received more inquiries this year than usual on how to treat fire blight cankers. Upon investigation many of these have been found to be frost cankers. In late summer and fall, the dead bark began to crack and slough off from the tree and rot fungi were often present. A sparse or thin foliage on certain limbs or over the entire tree has been an indication of winter injury. This condition has occasionally been manifested without killing of the bark and in such cases the sapwood has been injured.

REPAIR WORK

Orchardists were advised early in the season to postpone treatment until a later date to give the tissue which had not been completely killed an opportunity to heal. It was impossible to forecast by an examination of the tree early in the spring the extent or seriousness of the injury in either apple or peach. In fact some peach trees which appeared absolutely dead in March, being dark brown into the sapwood of the trunk and main limbs, finally recovered. The peach, to be sure, has far greater recuperative powers than the apple; but some of the injury on the apple, particularly on old trees, proved to be only in the bark with the cambium uninjured. Such healing beneath the dead bark in old apple trees where the injury was merely superficial, has been excellent in some orchards noted. Had these cankers been treated early, large areas of dead bark would have been removed and big wounds would have been left; healing has been complete, however, without treatment and only a superficial layer of dead bark remains. In young trees the killing has often extended entirely around one or more of the main limbs and occasionally around the trunk, thus girdling and killing the tree. In young trees of the tender varieties the sapwood as well as the bark has been killed and healing has progressed very slowly if at all.

The presence of borers complicates the treatment of the winter injury. The dead bark has afforded these insects a natural protection from their enemies with the result that most frost cankers particularly in the wooded sections of southern Indiana are "literally alive" with borers of the flat-head variety. These borers enter the living tissue and if left to themselves soon finish the work of destruction begun by the winter killing. For this reason it is imperative that these cankers be treated as soon as possible. The first step in this direction is to determine whether or not the tree is worth repairing. This cannot be done by rule-of-thumb. Each tree will be a problem in itself and will call for the exercise of good judgment. Where the crotch injury involves a con-

siderable portion of several main limbs and the sapwood beneath is dead, the tree had better be removed. It may be possible to renew these trees by cutting them off near the ground at a decided slant, saving a sprout



Fig. 4. This tree had two limbs girdled by winter injury; these have been properly sawed off, flush with the main stem

from above the graft. The large, uninjured root system will soon grow a top and a profitable tree will be produced much sooner than by replanting. In young trees up to six years old, renewing from the trunk would undoubtedly be a good practice. In trees older than 10 years, however, the wound would be so large that it is doubtful if it would heal over before decay set in and weakened the tree. With all such renewal, the danger of the heavy sprout breaking away from the old trunk during high winds is also imminent.

It will take a thorough examination of the tree to reveal the true extent of the injury and to decide for or against saving it. If the dead bark is not actually removed in this inspection all doubtful places should at least be tested with a knife. If satisfied that the tree has a fair chance of recovery the first operation will be to remove dead limbs as this will facilitate the other work. The cuts should be made as close to the main trunk or branch as possible and parallel with it. The dead bark should be cleaned away with a sharp knife or gouge. It will be necessary to go as far into the live bark and sapwood as the borers have worked, in order that they may be killed. For this purpose a one-inch Turners chisel or gouge, beveled on the outside, is a very satisfactory tool. The edges of the wound should be trimmed neatly, leaving the surface of the

sapwood somewhat lower at the margin of the wound so the bark can more readily heal over the injury. Healing will also progress more satisfactorily if the extremities of the wound are left pointed rather than rounded or square.



Fig. 5. The wound after cleaning out with a sharp knife or gouge and having the edges neatly trimmed

The cleaning out of the wound should be followed by painting the exposed wood. A white lead paint, somewhat thicker than would be used in ordinary outdoor work will answer the purpose. To each quart of paint add one ounce of finely pulverized mercuric bi-chloride, (corrosive sublimate) and stir thoroughly. This will increase the fungicidal value of the paint and retard the growth of wood-decaying organisms. Powdered corrosive sublimate in bulk may be purchased through any druggist. It is very poisonous if taken internally and must be handled accordingly. It is realized that the painting of wounds is not universally advocated because of retarded healing, but under Indiana conditions where heart rot, blister canker and other diseases appear, it is felt that the painting of large wounds is advisable.

A certain amount of drying back with resultant killing of the margin of the newly made wounds may take place during the winter, but this should not be serious. In any case where borers are present they must be removed if still greater injury is to be avoided. There may be some winter injury where borers are not present and under such circumstances the canker may be treated the next spring. Freedom from borers should not be taken for granted as they are almost universally associated with winter injury in this state.



Fig. 6. The exposed wood covered with a good disinfectant paint to keep out moisture and disease

CARE OF WINTER INJURED TREES

In addition to canker treatment, winter-injured trees should receive the best of care and be given every encouragement for vigorous growth. The usual winter spray should be applied. Pruning will not generally be necessary, for in treating a winter-injured tree, one and sometimes several dead limbs have to be removed and a further reduction of the leaf surface would not be desirable. However, where a thin top and small leaves with absence of bark injury indicates that the trouble is largely in the sapwood, removal of some branches may not be out of place. A good mulch of barnyard manure, at least 200 pounds for a 10-year-old tree, will assist in providing and saving moisture which will be a wonderful help to the tree. Apply not closer than two feet to the trunk and well out under the spread of branches. If manure is not available, straw or shredded corn fodder is recommended. Where cultivation has been practiced it may well be continued, but where the trees are in sod and it is impossible to apply a manure mulch, the application of two to five pounds of nitrate of soda scattered broadcast beneath the tree is suggested for the poorer soils.

Winter-injured peaches should have the winter spray and summer cultivation. If the trees have not already received attention, assuming they are worth saving, the dead limbs may be cut out but as for cutting away the dead bark and painting the wounds, that is neither necessary nor desirable in the peach. The tops of the trees should not be severely cut back at this time. Many of the injured trees have good prospects for fruit in 1919 and knowing that almost every year the crop is reduced by cold winters or late spring frosts it would be doubtful wisdom to do much early cutting, thus reducing possible production for 1919. It will be in order, however, to head back several of the tallest branches or leaders to a lateral branch. Trees that have been heavily pruned or "dehorned" will bear no fruit in any case and should be thinned out to suitable foundation shoots which will form the new tree.

CONCLUSIONS TO BE DRAWN FROM THE WINTER OF 1917-18

It is well to learn the lessons afforded by the winter of 1917-18, but hasty conclusions as to the future effect on the fruit industry, the suitability of varieties for planting and the best orchard practices to follow, are to be avoided. In this connection, it should be emphasized that nothing like the winter noted has ever been witnessed in the history of the fruit industry of Indiana. Aside from elevation and variety, the hardness of the tree was influenced by the growth conditions prevailing during the summer of 1917; that season was short and wet. It is probable that many trees failed to mature their wood properly. Had a normal growing season preceded the severe winter, there might have been no killing in the apple. Thus, even should a like winter come again, unless it were preceded by a similar growing season, the results would not necessarily be duplicated. The chance, therefore, of apples again winter-killing to a similar degree are small.

The effect of maturity and preceding summer's growth on winter injury is well illustrated in the orchard soil management experiment at Laurel, Indiana, being conducted by this station. Trees which had been permanently in sod with no mulch, making the least growth with a tendency toward early maturity, suffered much less from winter-killing than trees which were cultivated or heavily mulched with straw, inducing later growth and deferring maturity. It should be understood that the trees growing in sod were making sufficient growth to be healthy. Trees weakened from any cause frequently suffered worse from winter injury. Circumstances thus offset the better systems of management. It would be absurd however to grow trees under poor methods merely that they might survive such another set of unusual conditions. There are more important considerations, such as profit from the orchard.

BRIDGE GRAFTING

Bridge grafting which is sometimes resorted to when the bark has been injured by rabbits or other means, may be found useful in the repair of winter injury. By means of properly inserted scions, a limb or the tree itself may often times be saved. Such work should be done in the spring, before the leaf buds open. The wound is treated as previously described and if it girdles a considerable portion of a limb or the trunk of a valuable tree, bridge grafting may be employed.

The scions are cut from the last year's growth of the tree and are of such a length that they will span the wound and extend one and one-quarter inches beneath the live bark at its upper and lower margins. At each end of the scion a sloping out one and one-quarter inches long is made. The blade of a knife is then inserted "flat-wise" beneath the bark

at the upper and lower margins of the wound at the point where a scion is to be placed. The sloping butt-end of the scion is then inserted under the fresh bark in the lower incision and the terminal end in the upper one, so that the cut surfaces come next to the wood of the tree where they are held in place by a small nail. The scions should not be split in nailing. They may be placed every two or three inches over a large wound thus serving as a "bridge" to permit the flow of sap. After the scions are in place the grafting wounds should be coated with grafting wax to prevent evaporation and exclude disease.

Grafting wax may be made by heating together over a slow fire, one part of tallow, two parts of bees wax and four parts of resin. After melting and stirring, a suitable quantity may be poured into cold water and with greased hands pulled until it is about the consistency of molasses candy, when it is worked into balls and wrapped in greased paper for future use.

INARCHING

Grafting by approach or inarching is done by utilizing a sprout either from the roots or below the injury or by planting one or more young trees at the base of the injured tree. This may be carried to such an extent as actually to cut the old tree off from its original trunk in a few years and leave it supported by the seedlings at its base.

With a sharp knife slice off from the old tree, above the injury, a narrow portion of bark about an inch and a half long, exposing the cambium. The bark of the sprout or young tree opposite this cut is now treated in a like manner and the two cut surfaces are brought together so that the cambium of



Fig. 7. A bridge graft with scions in place. The scion at the left is a poor one having been cut from a succulent water sprout with few buds; the others are good

the whip is touching the cambium of the old tree. A small nail serves to hold the parts securely together and the operation is completed by covering with grafting wax.

One Indiana fruit grower who has had much experience along this line, has found that where the young tree has a portion of the top cut off and the end thus left is inserted directly into the older tree, the chances of failure in the graft are large; whereas if the terminal is allowed to continue beyond the union as described above, it facilitates the flow of sap and the grafts "take" in practically every case. After the union is complete, however, the terminal portion of the young tree should be cut back to the graft.

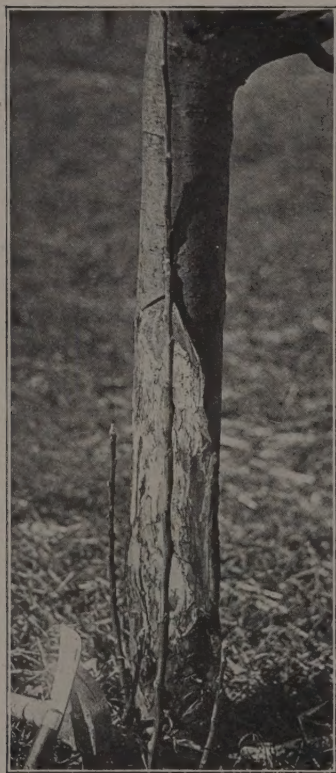


Fig. 8. An inarch graft ready for waxing. The one-year-old sprout in the foreground has been joined with the older tree at a point just above the wound

INSECTS ASSOCIATED WITH WINTER INJURY¹

THE FLAT-HEADED APPLE TREE BORER.—This insect attacks our fruit trees and also many shade and forest trees, so that it is quite a common pest. Like other borers, it prefers trees in a weakened or run down condition. The writer has seldom found healthy, vigorous trees infested, and then only slightly.

The adult is a dark metallic colored beetle varying in size but usually about one-half inch in length. The beetles emerge during early summer, when they fly during the day and glue their eggs to the bark, usually on trees that are diseased or about wounds or cankered areas over the tree.

The larvae or borers, the stage the orchardist is most familiar with, are light yellow in color and measure twice the length of the adult beetle. The head is greatly enlarged and flattened, hence the name flat-headed borer. The borers work just beneath the bark, excavating broad, rather flat channels and are found in greatest numbers, especially in

the case of winter injured areas, at the junction of the dead and live wood. When almost full grown, they may burrow deeper into the sapwood, but return near the bark to pupate, where the adult emerges through an elliptical exit hole in the bark.

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From the description of the work of the insect, it may readily be seen that no spray would be of any value in its control, so the only remedy that can be used with satisfactory results is the practice of "worming," which consists of cutting the borers out with a knife or gouge and painting the wound with a good paint.

Washes of fish oil and whale oil soap applied during June and July may prevent the beetle from depositing her eggs on the bark.

Rigid adherence to methods of good orchard practice, which requires the burning of all dead trees, branches and prunings from the orchard, together with correct soil management, should give practical exemption from the ravages of this insect.

THE FRUIT-TREE BARK BEETLE.—Winter injured trees, or trees low in vitality from any other cause, are often the object of the attacks of these miniature borers. They give a tree the appearance of having received a charge of bird shot and hence they are often popularly known as shot-hole borers.

The adult is a very small beetle, measuring about an eighth of an inch in length and dull black in color. Beetles pass the winter as both larvae and pupae beneath the bark, then mature and emerge as adults during April and May. The females then construct a brood chamber in the sapwood along the sides of which they bore small holes where they lay their eggs. The eggs hatch in a few days and the small grubs start eating their way from the brood chamber through the sapwood. It is the small whitish larvae, less than one-fourth inch in length, that cause the principal injury and it is this stage the orchardist should guard against.

Their presence is usually detected by a gummy exudate issuing from the bark or by the general lack of thriftiness in the tree. It is a safe assumption that only weak and devitalized trees are attacked. This weakened condition may have been brought about by winter injury, San Jose scale, lack of fertility, sun scald, blister-canker or any other conditions that cause the initial decline in a tree's vigor and thriftiness. The attacks of the borers usually follow one of these primary causes.

Since the grubs are so small and numerous, it is quite apparent that the only way to combat this pest successfully is to cut out and burn all dead trees and all dead and injured areas. The exposed wounds should then be painted over with a good paint.



Fig. 9. The trees at the foot of the hill in the young apple orchard suffered much more from winter injury than those on the higher land

Available publications of the Purdue University Agricultural Experiment Station treating on pomological subjects:

- Bulletin No. 194. The Indiana Farm Orchard. Operating Costs and Methods
- Bulletin No. 200. Strawberry Varieties and Cultural Hints
- Bulletin No. 201. Varieties of Blackberries and Raspberries with Notes on their Care
- Bulletin No. 205. Soil Management Investigations in a Young Apple Orchard
- Bulletin No. 207. Gooseberries and Currants
- Bulletin No. 212. Plums and Cherries
- Circular No. 67. The Planting and Care of the Young Apple Orchard
- Circular No. 69. Peach Growing in Indiana
- Circular No. 70. Apple Diseases in Indiana
- Circular No. 74. The Indiana Horticultural Society's Experimental Orchard
- Circular No. 87. Winter Injury of Fruit Trees